DEPARTMENT OF THE AIR FORCE
ARMSTRONG LABORATORY (AFMC)
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MEMORANDUM FOR 645 MedGrp/SGB 19 Dec 94

FROM: AL/OEMH

SUBJ: Consultative Letter AL/OE-CL-1994-0203, Review of Dioxin Sampling Results from C-123 Aircraft, Wright-Patterson AFB, OH and Recommendations for Protection of Aircraft Restoration Personnel.

1. 645 Med Group/SGB requested we review the dioxin swipe sampling results from a C-123 aircraft located in the museum annex at Wright Patterson AFB, OH. Restoration efforts are planned for the aircraft for eventual display at the museum. The complete restoration process could take 18 months to complete. Initial concern was raised by museum staff to 645 Med Group/SGB prior to restoration since the aircraft was reportedly used in defoliation efforts in Viet Nam and carried agent orange. Three swipe samples were collected from horizontal surfaces within the interior of the aircraft and one sample was collected on the underside of the port side wing. All four samples tested positive for dioxin congeners. The museum staff have secured the aircraft to prevent entry.

2. On 20 Nov 94, AL/OEMH personnel viewed the aircraft and were shown actual sample locations. At that time, museum staff reported that the tanks used for the actual spraying operation were also located on the installation along with the spraying booms. The museum also planned to restore the tank and booms and connect them back to the aircraft. The tank and control mechanism were found in a restoration staging area near the museum. Access to the tank is not limited. The tank is sealed with no indication about the contents. Swipe samples have yet to be collected from the tank.

3. The samples were analyzed by Pace Incorporated Environmental Laboratories for congeners of dioxin, the polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs). Because 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) is the most toxic PCDD congener, the results from the swipe samples were used with the congener specific Toxicity Equivalence Factors (TEFs) to calculate the 2,3,7,8-TCDD toxicity equivalence (TEQ) for each swipe sample. The sample results, TEF, and TEQ for each sample are reported in Table 1. An independent review of the data by Dr John Stanley, Midwest Research Institute, verified the accuracy of the results and indicated that, based on the relative abundance of specific congeners, the source was likely from agent orange (Attch 3).

4. The state of New York (Department of Health) developed recommended re-entry exposure guidelines for PCDDs and PCDFs after the infamous Binghamton State Office Building fire

involving wide spread contamination of PCDDs and PCDFs through the ventilation system resultant from PCB transformer fires. The New York concentrations, expressed as nanograms per meter square of surface area, were developed using the EPA risk assessment paradigm based on results of toxicity studies completed by the National Toxicology Program (NTP). The method used by New York to develop their recommended concentrations and the values were validated by the Subcommittee on Dioxin, Committee on Toxicology (COT) in their 1988 report "Acceptable Levels of Dioxin Contamination in an Office Building Following a Transformer Fire". The value for re-entry is 25 ng/m^2 (for surface contamination), and was calculated based on exposure parameters of 2 pg/kg per day ingestion (surface ingestion and/or inhalation) by a 50 kg person working 250 days per year for 30 years. The accumulated lifetime ingestion would be 750 ng. In the COT report, it is recognized that the lifetime ingestion would not likely be reached with the requisite exposure parameters for office workers and, therefore, the 25 ng/m^2 level is considered conservative. The guideline was based on reproductive risks and carcinogenesis with cancer risks derived from the studies conducted and reported by Kociba et al. (1978) and the 1982 NTP bioassay data.

5. According to the COT report, humans can exhibit chloracne from short-term exposures to high concentrations of PCDDs. Other, less well established effects in humans include: altered heme synthesis, changes in liver function tests, peripheral neuropathy and changes in serum lipid concentrations. Cancer study results are inconsistent, with some showing an increase in soft tissue sarcoma and no increase in others. Additionally, studies of industrial workers who were exposed to higher concentration of PCDDs have not shown a consistent pattern of increased risk of cancer. None the less, the New York re-entry level of 25 ng/m^2 is correlated to a reported lifetime cancer risk estimate of $9x10^{-8}$ to $2x10^{-4}$.

6. Interpretation of Sample Results: The results from the samples collected within the interior surfaces of the aircraft are likely to be representative of other locations of limited traffic near the agent orange spraying equipment. The swipes were collected from locations somewhat protective of routine crew movement and routine historical maintenance. Therefore, these samples are most likely not indicative of the surface contamination throughout the entire cargo area of the aircraft. Extensive sampling of the interior of the aircraft to fully characterize the extent of contamination would be prohibitively expensive. Based on the exposure parameters used by the state of New York, and using 18 months as the entire exposure period for aircraft restoration crew and a 70 kg man, exposed for 250 days per year for 1.5 years, the calculated daily intake concentration would be 29 pg/kg with a corresponding surface contamination level of almost 360 ng/m^2. This would only be an acceptable level for a lifetime exposure if restoration personnel had no additional lifetime exposure. Additionally, the 25ng/m^2 exposure concentration was calculated based on an office worker's casual contact with contaminated surfaces. What this calculation does show is that the re-entry guideline of 25 ng/m^2 is based on very specific exposure parameters and measured concentrations, and a higher surface contamination could be acceptable.

7. Safety and Health Recommendations for Restoration Personnel: Due to the uncertainty in measured PCDD concentrations on the interior of the aircraft representing the average contaminant concentrations, the anticipated aggressive restoration techniques, the length of time restoration personnel will be involved in the project and the identified potential adverse human

health impacts, exposure to restoration personnel from contaminated dirt and paint should be maintained at the lowest possible exposure levels. This would include a combination of personal protective equipment, modified work practices, and containment of the contaminated dusts within the aircraft and appropriate decontamination. Because of the nature of contamination and the irregular nature of the contaminated surfaces, decontamination of the entire interior of the aircraft (either with or without additional sampling), is not recommended. Additional controls that should be implemented for the duration of the interior surface preparation of the aircraft are as follows:

a. Provide a containment for the aircraft to reduce the transport of dusts to the exterior. This would include thoroughly masking cracks and small holes, and sealing off other portions of the aircraft presumed to be free from contamination (i.e the cockpit). The containment should also include an area for decontamination of clothing and hands for the workers.

b. Restoration personnel actively involved with interior surface preparation should wear Tyvek coveralls and full-faced high efficiency particulate air filters (HEPA). In general, controls implemented during an asbestos removal project would be appropriate in this situation.

c. Air should be sampled for total dusts during surface preparation activities to document the levels of dust.

d. Collect at least one additional swipe sample in an area thought to be free from PCDD contamination (i.e the cockpit area).

e. Provide appropriate training as required for respirator use (and fit-testing if needed), decontamination of protective clothing and self after removal of protective clothing, and appropriate work practices to minimize dust. These work practices include:

1. Remove stored items from the interior bay of the aircraft and decontamination with either hexane soaked rags, or soap and water. The bags of material stored in the bay should be removed, and the plastic bags discarded. The aircraft canopy should be decontaminated with soap and (mimal) water. Any decontamination materials should be handled as dioxin contaminated wastes.

2. Minimal scraping of painted surfaces in preparation for painting. Mechanical sanding should be completely avoided, and hand sanding minimized. Surface areas covered with grease or oil should be decontaminated with hexane and cloths and treated as dioxin contaminated wastes.

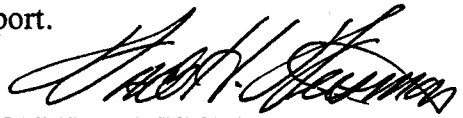
3. Sealing of scraped surfaces with commercially available sealing mixture. Once the interior of the aircraft is painted, appropriate labeling should indicate that surfaces beneath the painted surfaces are dioxin contaminated.

f. Once the aircraft is restored, viewing by tourists should be limited to the exterior of the aircraft only. The interior of the aircraft should not be used to store any materials or spare parts.

g. We recognize that our recommendations do not result in the complete decontamination of the aircraft. These recommendations are made to limit exposure to aircraft restoration personnel, limit the amount of dioxin contaminated wastes generated, and not require extensive, additional dioxin sampling. However, the interior of the aircraft must be conspicuously labeled so that personnel involved in any future restoration of the aircraft will be aware of the dioxin contamination under the painted surfaces.

8. Spray Solution Tank and Associated control equipment: Since the tank has not been sampled and the interior contents are unknown, the first step would be to collect surface swipe samples from the exterior of the tank and the distribution control equipment. The interior of the tank should be inspected, if there is no standing liquid, the tank should be assumed to be heavily contaminated and swipe sampling is not recommended. If there is free standing liquid in the tank, a sample should be collected for analysis, and if positive for PCDD, removal of the liquid would be necessary. Since the tank has been exposed to UV radiation from being stored outside, it is possible that any contamination on the exterior that was exposed to sunlight may have been adequately degraded. Therefore swipe samples should be collected from less accessible locations. The stainless steel webbing covering the flexible pipe and permeable surfaces could be assumed to be heavily contaminated. A representative swipe sample should be collected from these surfaces. These recommendations for the tank are based on the assumption that the tank will be included in the restored aircraft or will be turned into DRMO for excess. For either of these scenarios, it will be necessary to measure the extent of surface contamination.

9. Conclusions: The interior of the C-123 aircraft under discussion is heavily contaminated with PCDDs. The aircraft is scheduled for repair by museum personnel with eventual plans to put it on display. During restoration, museum personnel could be exposed to dioxin contaminated dusts. The cost of congener specific dioxin analysis and the slight increase in characterization of contamination in the aircraft, limits the additional samples that should be collected. Swipe samples should be collected from the exterior of the tank and spraying equipment. All work practices should be conducted to limit the generation of dust, following the recommendations discussed in this report.



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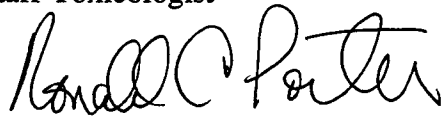

RONALD C. PORTER, GS-11
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Attachments
1. References
2. Table 1 - Sample Results
3. Letter, Midwest Research Institute

References

1. Kim, Nancy K., and Hawley, John, 1985. Re-Entry Guidelines, Binghamton State Office Building. Bureau of Toxic Substances Assessment. Division of Environmental Health Assessment, New York State Department of Health, 22 pp.

2. Doull, John, et al. 1988. Acceptable Levels of Dioxin Contamination in an Office Building Following a Transformer Fire. National Academy Press, Washington, D.C. 24 pp.

3. Kominsky, J.R., 1988. Health Haxard Evaluation Report No. HETA-86-092-1870, 50 Staniford Street Office Building, Boston, Massachusetts. 55pp.

4. Kociba, R.J., et al. 1978. Results of Two-year Chronic Toxicity and Oncogenicity Study of 2,3,7,8-tetrachlorodibenzo-p-dioxin in Rats. Toxicology and Applied Pharmacology, 46:279-303.

Attachment 1

Dioxin Sampling Results C-123 Aircraft
Wright Patterson, AFB, Converted to 2,3,7,8-TCDD Equivalents
Reported in Nanograms per sample

Congener	TEF	IK1355-1 Reported	Interior(midship) Equivalent	IK1355-2 Reported	Interior(tail) Equivalent	IK1355-3 Reported	Interior(tail) Equivalent	IK1355-4 Reported	Exterior(wing) Equivalent	IK1355-5 Reported	Exterior(wing) Equivalent
2378 TCDD	1	14.22098	14.22098	2.06846	2.06846	2.40728	2.40728	0.04015	0.04015	0.00255	0.00255
12378 PeCDD	0.5	0.32149	0.16075	0.12507	0.06254	0.12687	0.06344	nd		0.001	0.0005
123478 HxCDD	0.1	0.16579	0.01658	0.0482	0.00482	0.04856	0.00486	0.00072	0.000072	nd	
123678 HxCDD	0.1	0.13799	0.01380	0.04	0.00400	0.03734	0.00373	nd		nd	
123789 HxCDD	0.1	0.09205	0.00921	0.02299	0.00230	0.0167	0.00167	nd		nd	
1234678 HpCDD	0.01	0.58138	0.00581	0.12867	0.00129	0.08619	0.00086	nd		nd	
OCDD	0.001	1.5384	0.00154	0.60159	0.00060	0.31904	0.00032	0.03717	3.72E-05	0.00697	6.97E-06
2378 TCDF	0.1	0.09596	0.00960	0.02567	0.00257	0.02618	0.00262	nd		0.00061	0.000061
12378 PeCDF	0.05	0.01578	0.00079	nd		0.0045	0.00023	nd		nd	
23478 PeCDF	0.5	0.01995	0.00998	0.00542	0.00271	0.00682	0.00341	nd		nd	
123478 HxCDF	0.1	0.04878	0.00488	0.01603	0.00160	0.01472	0.00147	0.0034	0.00034	nd	
123678 HxCDF	0.1	nd		0.00513	0.00051	0.0049	0.00049	0.0024	0.00024	0.00021	0.000021
123789 HxCDF	0.1	nd		nd		nd		nd		nd	
234678 HxCDF	0.1	0.02658	0.00266	0.00512	0.00051	0.00615	0.00062	0.00261	0.000261	nd	
1234678 HpCDF	0.01	0.11585	0.00116	0.0448	0.00045	0.03968	0.00040	0.00928	9.28E-05	nd	
1234789 HpCDF	0.01	0.01388	0.00014	nd		0.00366	0.00004	nd		nd	
OCDF	0.001	0.14735	0.00015	0.04777	0.00005	0.04129	0.00004	nd		nd	
Total TEQ			**14.458**		**2.152**		**2.491**		**0.041**		**0.003**
Sample Area			100cm2		100cm2		100cm2		100cm2		100cm2
Mass/Area			1400ng/m2		200ng/m2		250ng/m2		4.1ng/m2		0.3ng/m2

FROM: MRI Midwest Research Institute
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Pages, including cover page:

TO: Ron Porter, PhD
Armstong Laboratory
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Date: November 19, 1994

FAX NUMBER: 210-536-2315

VOICE NUMBER: 210-536-6127

FROM: John Stanley

FAX NUMBER: (816) 753-5359

VOICE NUMBER: (816) 753-7600 ext 1160

REFERENCE: Review of Data for Dioxins

Ron

I have reviewed the data summaries that you provided to met on Friday, November 18, 1994. The data were generated via method 8290 (a high resolution MS approach) using a VG Autospec (an instrument of high quality and good sensitivity). Samples analyzed were swipes (or wipes) and data appears to be reported in units of picograms/wipe or pg/WP.

Based on the data presented and the information on the method and instrumentation, my impression is that you have a reliable data set from which to work. Some observations regarding the data indicate that the primary source for some samples (such as IK1355-1) is likely from an agent orange type background. This is based on the fact of the prominence of the 2,3,7,8-TCDD in relation to total TCDD and the relative contribution from the other PCDD and PCDF congeners and homologs. The other response for PCDDs and PCDFs are likely from a different but contributing source. It is difficult to say much more from the data presented. The fingerprints from the detailed HRMS data packages would provide much more input regarding the potential sources of the other compounds.

The levels reported for samples IK1355-2 through 4 should be easily seen, particularly for 2,3,7,8-TCDD. The levels reported for the method blank (MB-IK1355) and sample IK1355-5 are likely approaching detection levels. I am presuming that sample IK1355-5 is a field blank as the levels are very close to the laboratory method blank (prepared from filter paper). It is not possible to say much about the MB level or number 5. However, I am assuming that the tetra and penta levels are reflective more of background in the filter matrix rather than glassware carryover cited in the narrative.

Hope this information is useful to you. If there are questions, please call.